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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04M 3/42

A2

(11) International Publication Number: WO 99/66700

(43) International Publication Date: 23 December 1999 (23.12.99)

(21) International Application Number: PCT/FI99/00496

(22) International Filing Date: 8 June 1999 (08.06.99)

(30) Priority Data:
09/098,565 17 June 1998 (17.06.98) US

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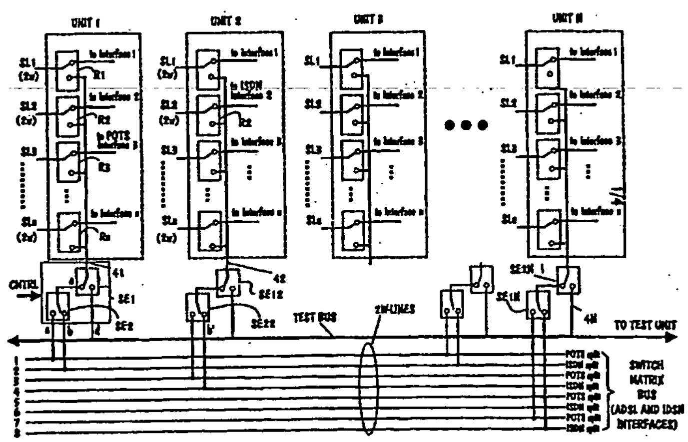
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: UPGRADING OF SUBSCRIBER CONNECTION



(57) Abstract

Upgrading of a subscriber connection to another requires an upgrading work done by an electrician. According to the invention, the type of connection is upgraded by remote control. A switch matrix bus including several parallel lines (1–8) is placed in the access node. Connected fixedly in advance to the bus are interface units of an ADSL connection and, when desired, of an ISDN connection, however, in such a way that only one interface is connected actively to one bus line at a time. A controlled switch element (SE1, SE2) connects a line coming from a test relay (R3) located between the end of the subscriber line (e.g. SL3) and its interface to the switch matrix bus instead of the test bus. With a remote control signal supplied through network management a choice is made of which test relay connects the connected subscriber line to the controlled switch element. Since the line or wire couple of the switch matrix bus for its part is connected fixedly to the interface of the ISDN or ADSL subscriber connection, this means that the subscriber line can be connected by way of the switch matrix bus to the ISDN or ADSL interface instead of the original analog interface, or the subscriber line may be connected to the ADSL interface instead of the original ISDN interface. In this way, any subscriber line may be upgraded to a connection of another type by remote control.

Upgrading of subscriber connection

Field of the invention

This invention concerns upgrading of the type of subscriber connection in a telephone network, wherein the subscriber connection may be an analog PSTN connection or a digital ISDN connection or any other digital connection.

Background of the invention

Until the 80s every subscriber was connected to the local telephone exchange by using a copper twin cable. From the subscriber's wall socket the twin cable leads to a main distribution frame, where the individual twin cables coming from several different subscribers are connected to a thicker cable containing several wires. A set of such cables may then be connected to a cable which containing hundreds and even thousands of wires is located farther away in another main distribution frame and which leads to the telephone exchange. The subscriber lines thus form a star-like network, the cables of which are connected in the local exchange. For this reason, most cables of a telephone operator are formed by subscriber lines.

Along with the digitalisation of the telephone network, attempts have been made to extend the digital network to be as close to the subscriber as possible. This has resulted in a basic solution of the kind shown in Figure 1. In this, the individual subscriber lines (that is, the copper twin cables) are connected with one network element functioning as an access node to the network. In the access node, an AD conversion of analog signals is performed, whereupon samples are multiplexed in a so-called subscriber multiplexer to a PCM line leading to the local exchange. For each subscriber line there is hereby a specific time slot on the trunk line. A concentrator may also be used instead of a multiplexer. On-hook/off-hook detection and loop measurements of subscriber lines are also performed in the access node.

The subscriber may have a plain old analog connection, a so-called POTS (Plain Old Telephone System) connection, whereby he may connect analog terminal equipment to a 2w subscriber line directly or by way of a piece of digital terminal equipment, such as a computer modem.

In the wake of the Internet's popularity, the need for quicker data transmission has grown, which is why there has been a strong increase

tion where a POTS signal is transmitted on one channel, or simultaneously an ISDN and an ADSL connection or a POTS and an ADSL connection may be available to the subscriber. All this is achieved by using the traditional 2w copper cable.

Figure 2 shows in greater detail circuits located in the access node. Physically, the access node may be located in a building or it may be a small cabinet on the street. The cabinet contains a rack including one or several frames. The frame includes plug-in units having circuit cards equipped with the necessary electric circuits. In the rear part of the frame there are backplane buses through which the plug-in units are connected electrically to one another. The individual subscriber lines leading to the access node all end at their own plug-in unit and in the subscriber line interface unit located therein, which adapts the subscriber line to the network interface. In Figure 3 the subscriber lines of ISDN subscribers thus end in ISDN cards 21, which may contain several individual subscriber line interface units, that is, several subscriber lines end on the same card. Similarly, the lines of those who have analog connections end in subscriber line interface units performing POTS adapting on POTS cards 22.

POTS and ISDN plug-in units are connected to backplane bus 29, to which unit 210 performing the network connection is also connected. The interface to the local exchange is here a standard V5.2, and unit 210 connects the access node with the exchange over 2Mbit/s trunk lines.

In addition, the access node also includes a test unit 211, which is connected to the network management system by way of a standard network management interface Q3. Test unit 211 is connected through a separate test bus 28 to the ISDN and POTS subscriber line interfaces 21 and 22. The test unit performs the conventional loop measurements of subscriber lines and supplies the results for use by the network management.

When subscribers find that their present POTS and ISDN connections are too slow for use on the Internet, they may require that the operator provide an ADSL connection offering a speed many times higher than the speed allowed by the ISDN connection. Such a need will occur by that time at the latest when more ADSL modems intended for the subscriber end of the subscriber line are commercially available. This is why the telecommunications operator may prepare himself for an introduction of ADSL technology by adding ADSL modems to the existing access node and by equipping new

a way that it will connect the desired subscriber line with the test bus for the time of measurements.

It is a problem with state-of-the-art access nodes of the described kind that always when a subscriber wishes to upgrade his connection type, e.g. a POTS subscriber wishes to have an ISDN connection or an ADSL connection or an ISDN subscriber wants an ADSL connection, an electrician must visit the subscriber to do the required connections. The end of the subscriber line is thereby connected to the new interface. Another consequence of upgrading on the site is that time will pass from the subscriber's request for connection upgrade to the performance of the upgrade, in the best case days, in the worst case weeks, depending on the operator. A method of performing a POTS->ISDN connection on the site is described in Patent Application WO 97/01938.

The problem remains the same, even if the access node is in connection with a local exchange. When an installation job is completed, it is possible that within a short time a new visit must be paid to the access node to upgrade the connection of another subscriber. In state-of-the-art access nodes the electrician's visit is the only way to perform upgrading.

It is an objective of this invention to solve the problem presented above. It is a special objective to perform upgrading of the subscriber connection without any visit by an electrician and almost immediately after the subscriber's request for an upgrading of his connection.

The established objective is solved in the ways defined in the independent claims.

Brief summary of the invention

The solution according to the invention consists of two parts: of a bus and of means of connecting the subscriber line to the bus. Firstly, the access node is provided with a special switch matrix bus including several parallel lines, each one of which is a 2-wire line. Interface units of a digital subscriber connection of a first type, here an ISDN connection, and interface units of a digital subscriber connection of a second type, here an ADSL connection, are connected fixedly to the bus, however, in such a way that only one interface unit of a first or second type is connected actively at the same time to one bus line. This connection is made in advance.

Figure 1 shows a method of connecting subscriber lines to a telephone network;
Figure 2 shows the structure of an access node;
Figure 3 shows the location of connections of different types on the frequency level;
Figure 4 shows connections of subscriber lines to interface units;
Figure 5 shows an access node having an addition according to the invention; and
Figure 6 shows connections of subscriber lines to interface units supplemented with the addition according to the invention.

Detailed description of the invention

Figure 5 shows a first item, which is a switch matrix bus 213, of the solution according to the invention. As can be seen, Figure 5 differs from Figure 6 in that it has a switch matrix bus 213. This bus is located as the backplane bus in the frame. There is access to the bus from ISDN interfaces 21 and from POTS interfaces 22. In addition, POTS splitter 25 and ISDN splitter 26 are connected to switch matrix bus 213. The switch matrix bus is an analog bus, that is, there are no bus clocks.

Although subscriber lines are not connected directly to the additional ISDN and POTS interfaces 23 and 24, the interfaces are nevertheless in connection with bus 29, through which they as well as interfaces 21 and 22 have access to the unit 210 making the network connection and they are further connected by this to the local exchange. These interfaces are needed for adaptation to the network of the audio frequency or ISDN frequency signal of the signal arriving from and going to the ADSL subscriber line.

Figure 6 shows a better view of the structure of the switch matrix bus. The bus is illustrated in the lower part of the figure. In this example, the bus includes twin wires 1-8. Each bus wire is a twin wire because the subscriber lines are also twin cables and the bus wire forms a part of the subscriber wire, as will be described more closely hereinafter. The switch matrix bus is located in the backplane of the frame as a backplane bus and POTS and ISDN splitters 25 and 26, Figure 5, are connected to the bus through the connectors of a plug-in unit. The methods of connecting are obvious to professionals and they will not be described here further. Thus each bus wire is connected fixedly either to ISDN splitter 26 or to POTS splitter 25.

tion of the switch element it will connect the common line 41 either to the test bus or instead to a predetermined wire of the switch matrix bus.

The switch element function can be formed by two relays, whereby the first relay SE1 connects a line 41 which is common to the relays R to another relay SE2. Thus the contact of the first relay is in pole d when it is desired that the common wire 41 is connected to the test bus, and in pole c when a connection of the common wire 41 with the other relay SE2 is desired. It should be noticed that wire 41 is a twin wire, so the relay poles are pairs accordingly.

The second relay SE2 connects the output pole c of the first relay either to pole a or to pole b. Pole a again is connected with one line of the switch matrix bus and pole b with the other line of this bus. In the figure, pole a is connected with line 1, which for its part is connected with the POTS splitter as was described above. Pole b is connected with line 2, which for its part is connected with the ISDN splitter, as was described earlier.

Corresponding connection arrangements are also made in group UNIT 2, but there the common line of the relays may be connected to the following line couple of the switch matrix bus, that is, to lines 3 or 4. Similarly, in group UNIT 3 the common line can be connected to lines 5 or 6 and in group UNIT 4 the common line can be connected to lines 7 or 8. A connection has now been made once to each line of the switch matrix bus and the connection pattern again starts from the beginning for group UNIT 5, that is, a connection is made to lines 1 or 2. When there are many groups, number N, by making a multistage connection of the outputs of relays SE2 of the different groups on the switch matrix bus approximately one connection point is obtained for its individual lines.

How to upgrade a subscriber connection to get another type will be studied in the following. It is assumed that the subscriber is a POTS subscriber. The subscriber's subscriber line is a twin cable SL3 terminating in group UNIT 1. Before upgrading of the connection, subscriber line SL3 is connected to POTS interface 3 when relay R3 is in its normal position. From interface 3, which is on some POTS card 22, Figure 5, the connection continues through bus 26 to group 210 making the network connection and thence further to the local exchange. When the subscriber has asked the operator to upgrade his present POTS connection to an ADSL connection, the operator will proceed as follows: From a computer in the network man-

connection to an ADSL connection. The data produced by the subscriber's terminal equipment is processed in the ADSL modem into an ADSL signal, which propagates along subscriber line SL2 to relay R2 of group UNIT 2, Figure 6. It prevents access of the signal to ISDN interface 2 by directing the signal to line 42 which is common to relays R. Relay SE12 directs the signal to relay SE22, which again by way of pole b' directs the signal to line 4 of the switch matrix bus. From line 4 the ADSL signal propagates to ISDN splitter 26, Figure 5, and thence further to ADSL converter 27. Processed by the converter the signal is then led to the SDH network. If the subscriber talks in an ISDN call at the same time, which call may also be a data call, it is separated in ISDN splitter 26 and it is led through ISDN interface 23 further to the telephone network.

Data coming to the subscriber from the network is processed in ASDL circuit 27, from which it is led as an ADSL signal through ISDN splitter 25, line 4 of the switch matrix bus and relays SE22, SE12 and R2 to subscriber line SL2. If at the same time an ISDN call arrives for the subscriber from the wire network, the call is directed from bus 29 to ISDN interface 23. Thence the call is directed through line 4 of the switch matrix bus and through relays SE22, SE12 and R2 to subscriber line SL2.

In this way, the ISDN subscriber connection has been upgraded to an ISDN+ADSL connection by remote control. In this case too the upgrade occupies the line common to the relays of group UNIT 2, so the type of connection of other subscriber lines coming to this same group can no longer be upgraded in the manner according to the invention by remote control.

In one group, upgrading can be done of one subscriber connection only. Since there are many groups and several subscriber lines are connected to each group, there is a rather small divided probability of two subscribers who wish upgrading of their connection being connected to the same group. When such a situation occurs, the electrician must pay a visit to the place to connect those connections permanently, which have already been upgraded by remote control. The test lines of groups will become free at the same time, whereby connection upgrading can again be done in the groups by remote control.

The outputs of switch elements of several groups can be connected to one line of the switch matrix bus. However, a barring effect then

Claims

1. Subscriber connection arrangement in a telephone network node, to which several twin-wire subscriber lines lead and through which subscriber terminal equipment has access to the telephone network, the node comprising:

several subscriber interface units of an analog subscriber connection (POTS) and several subscriber interface units of a digital subscriber connection (e.g. ISDN) of a first type, to each of which the end of the subscriber line is connected and which adapt the signal coming from the subscriber line to the telephone network and correspondingly adapt the signal from the telephone network to a signal for transmission on the subscriber line,

several test switches, each of which is located between the end of the subscriber line and the subscriber interface unit,

a test unit controlling the test switch to connect the end of the subscriber line either with the subscriber interface or with the test bus, through which the test unit performs measurements concerning the subscriber line,

whereby the test switches and thus the subscriber lines are arranged in groups so that the test switches of the group may connect the subscriber lines to a common line leading to the test bus,

the node further comprising:

a switch matrix bus formed of several wire couples and to several wire couples (1,...,8) of which is connected the subscriber interface (27) of a digital subscriber connection of another type, which interface performs adapting between the telephone network and a signal of another type propagating on the subscriber line, and

in each group (UNIT 1,...UNIT N), is a controlled switch element (SE1,SE2; SE12,SE22;...SE1N,SE2N) located on a common line (41,..4N) between the test switches (R1,...,RNn) of the group, which switch element connects the common line to one predetermined wire couple of the switch matrix bus or to the test bus.

2. Subscriber connection arrangement as defined in claim 1, wherein when upgrading the type of connection of a subscriber line (e.g. SL3), a test relay (R3) located between the subscriber line and the connected subscriber interface is used for connecting the subscriber line to the

edly to the first splitter (POTS Splitter 25), or to a wire of the switch matrix bus, which is connected fixedly to the second splitter (ISDN Splitter 26).

7. Subscriber connection arrangement as defined in claim 2, wherein upgrading of the type of subscriber connection of the subscriber line is performed by remote control through the network management system of the telephone network.

8. Subscriber connection arrangement as defined in claim 7, wherein the test unit performs upgrading of the type of subscriber connection in response to a command arriving from the network management system of the telephone network.

9. Subscriber connection arrangement as defined in claim 1, wherein the controlled switch element includes two relays, of which the first relay (SE1) connects the common line (41) from the test switches (R) to the second relay (SE2) instead of the test bus, and the second relay connects the common line further alternatively to one of two lines of the switch matrix bus.

10. Subscriber connection arrangement as defined in claim 4 or 7, wherein one of the lines of the switch matrix bus is connected fixedly to the first splitter (POTS Splitter 25), whereby an analog subscriber connection may be upgraded to an ADSL connection and the other line of the switch matrix bus is connected fixedly to the second splitter (ISDN Splitter 24), whereby an ISDN subscriber connection can be upgraded to an ADSL connection.

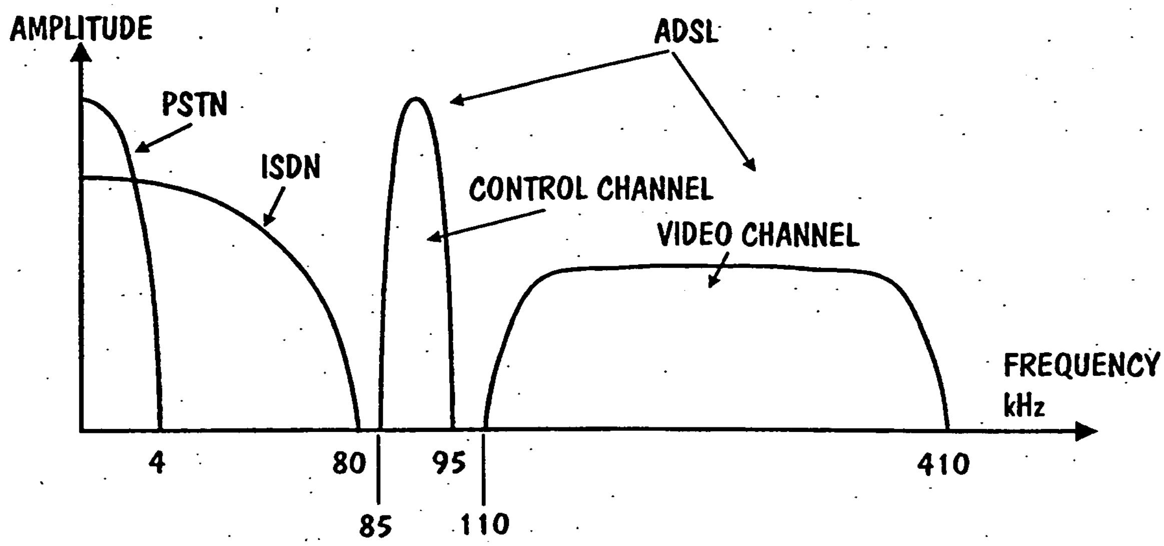

AMPLITUDE
PSTN
ISDN
ADSL
CONTROL CHANNEL
VIDEO CHANNEL
FREQUENCY kHz
4
80
85
95
110
410

FIG. 3

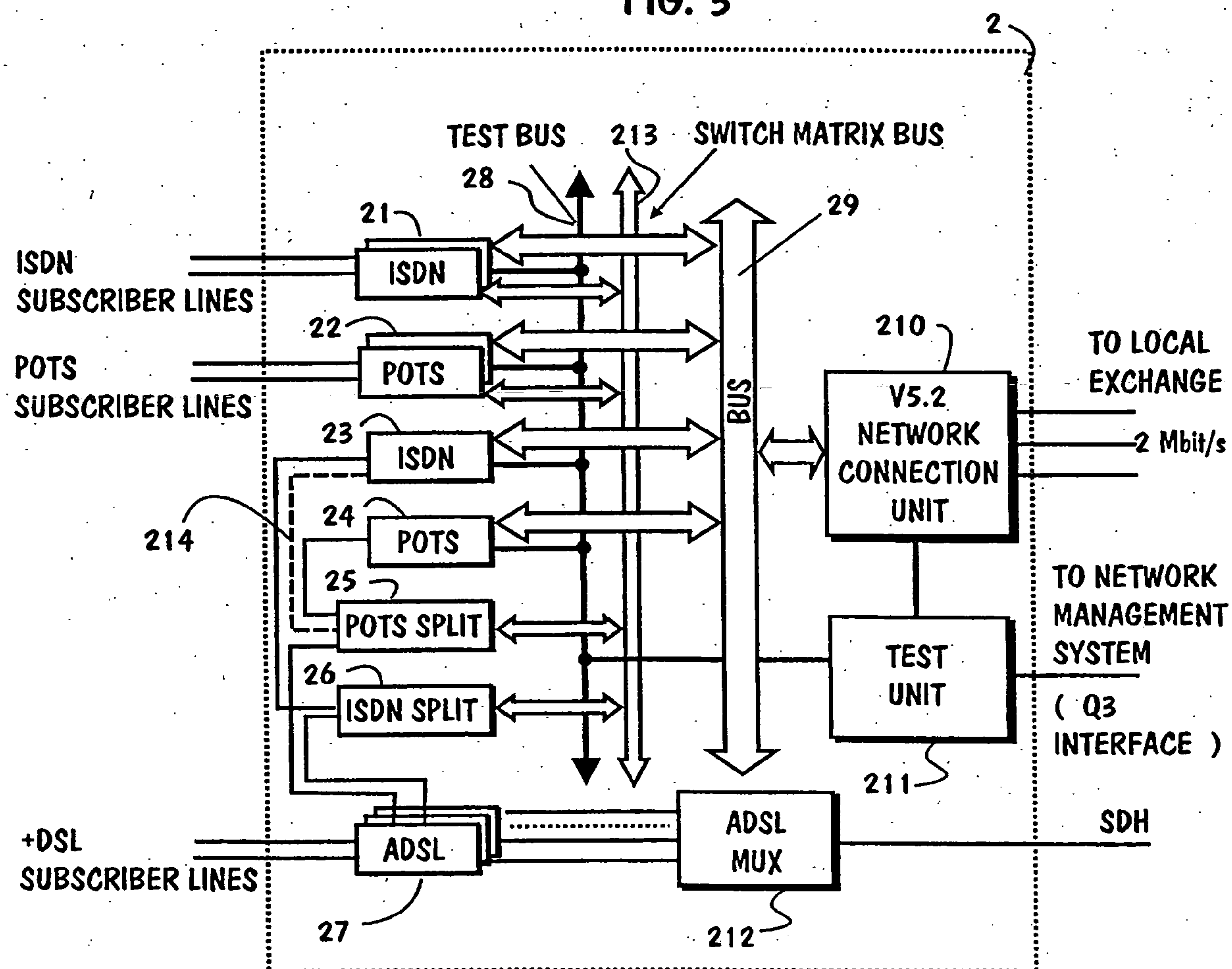

2
TEST BUS
213
SWITCH MATRIX BUS
28
29
21
ISDN
ISDN SUBSCRIBER LINES
22
POTS
POTS SUBSCRIBER LINES
23
ISDN
214
24
POTS
25
POTS SPLIT
26
ISDN SPLIT
BUS
210
V5.2 NETWORK CONNECTION UNIT
TO LOCAL EXCHANGE
2 Mbit/s
TEST UNIT
TO NETWORK MANAGEMENT SYSTEM
(Q3 INTERFACE)
211
+DSL SUBSCRIBER LINES
ADSL
27
ADSL MUX
212
SDH

FIG. 5

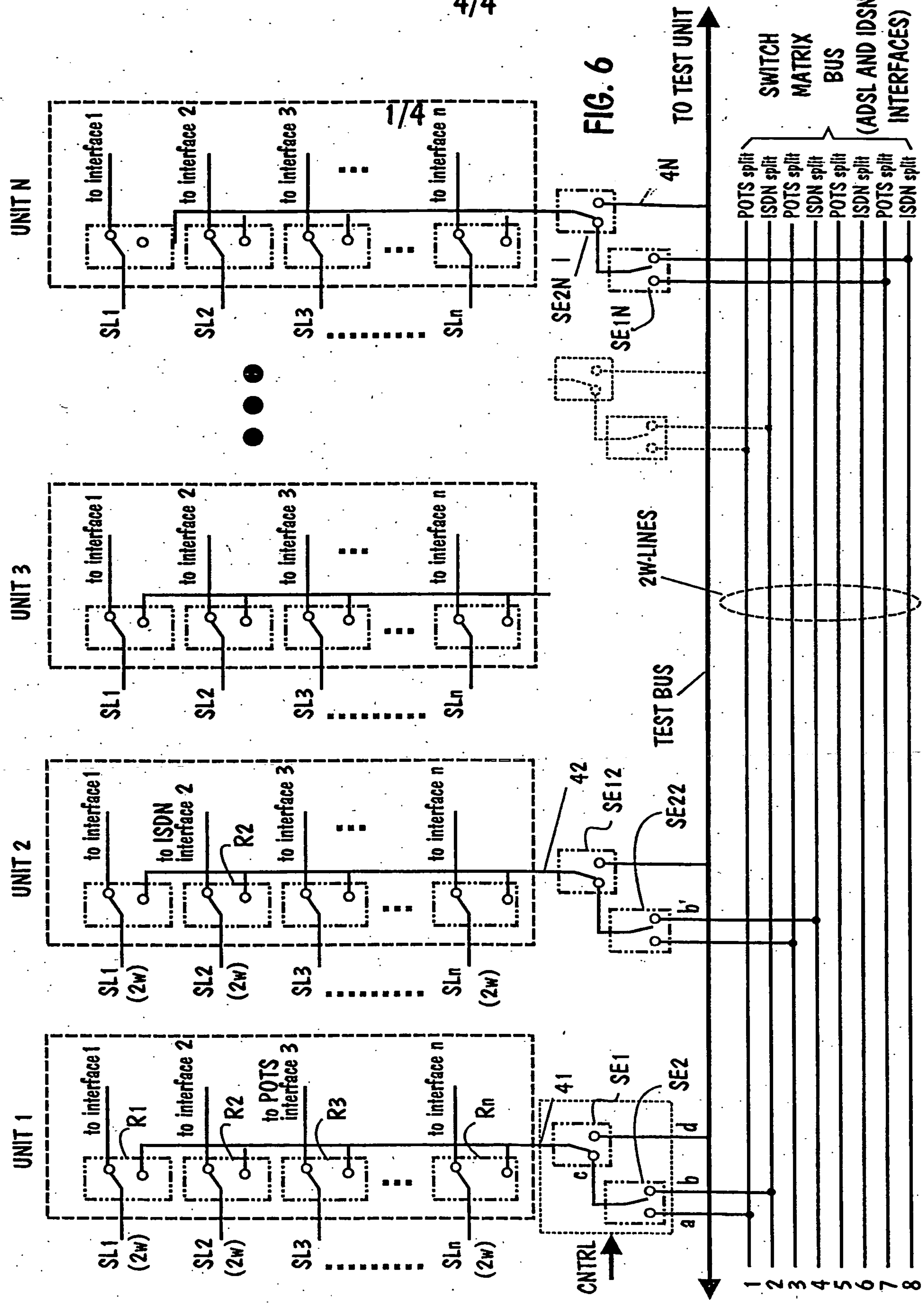

UNIT 1
UNIT 2
UNIT 3
UNIT N
to interface 1
to interface 2
to POTS interface 3
to ISDN interface 2
to interface 3
to interface n
R1
R2
R3
Rn
SL1 (2w)
SL2 (2w)
SL3
SLn (2w)
SL1
SL2
SLn
1/4
CNTRL
41
42
4N
SE1
SE2
SE12
SE22
SE1N
SE2N
a
b
c
d
b'
TEST BUS
2W-LINES
TO TEST UNIT
POTS split
ISDN split
SWITCH MATRIX BUS (ADSL AND IDSN INTERFACES)
1
2
3
4
5
6
7
8

FIG. 6